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I. Introduction

1. Space activities in the Czech Republic are a continuation of the space research experiments conducted by Czech researchers in the 1970s and 1980s within the framework of the Council on International Cooperation in the Study and Utilization of Outer Space (INTERCOSMOS) programme. After the political changes in former Czechoslovakia in 1990, Czech institutions could participate formally in the space missions of the European Space Agency (ESA) and the National Aeronautics and Space Administration (NASA) of the United States of America. One important step in that direction was a framework agreement for cooperation between the Czech Republic and ESA, signed in 1996. Other governmental agreements on scientific and technical cooperation have been signed, for example, with the United States and the Russian Federation. All these official documents have further increased the opportunities for the active participation of Czech scientists, researchers and representatives of industry in international efforts relating to the peaceful uses of outer space.

II. Space physics

A. Project Magion

2. The name Magion refers to a series of small magnetospheric and ionospheric satellites manufactured in the Czech Republic to be launched as "hitch-hikers" of Russian scientific satellites. Magions are designed to perform simultaneous measurements of space plasma parameters at two points that are not far from each other. The satellites also perform diagnostic research of particles actively injected from the main satellite. The Magion-type spacecraft have been selected as subsatellites of the Interball project. Magion 4 (C2-X) was put in orbit in 1995 as the Interball Tail Probe Subsatellite. Magion 5, the Interball Auroral Probe Subsatellite, was launched on 29 August 1996, together with the Interball 2 spacecraft, into an elliptic orbit with an apogee of 20,000 km and an inclination of 65 degrees. After only one day of operation, Magion 5 went out of control and ceased to transmit telemetric data because of a critical power shortage. The telemetric data analysis and laboratory tests showed that the failure was caused by a short circuit in the solar array, and it was decided that attempts to reactivate the spacecraft would be made periodically. After 20 months, on 6 May 1998, the spacecraft was successfully reactivated. The next day, all principal subsystems of Magion 5 were successfully activated. The satellite has been functioning well since then. The Magion

microsatellites, produced in the Czech Republic in collaboration with Austria, Hungary, the Russian Federation and Ukraine, have on board scientific instruments and sensors designed and built in Bulgaria, the Czech Republic, France, Hungary, Poland, Romania, the Russian Federation and Slovakia. The Institute of Atmospheric Physics of the Czech Academy of Sciences is the main designer and producer.

B. Micromeasurement of Satellite Acceleration project

3. In 1996, a microaccelerometer was flown on board Space Shuttle mission STS-79. The objectives of the experiment were three-axial acceleration measurements. This experiment was highly successful and has shown the excellent performance of the device.

4. Based on those results, a follow-up project, the Micro Measurement of Satellite Acceleration (MIMOSA) project, was begun at the Astronomical Institute of the Czech Academy of Sciences. The aim of the project is to launch a microsatellite with the accelerometer on board as the only scientific instrument. The core device of the experiment is an electrostatically compensated three-axial microaccelerometer with sensitivity reaching the level of 10^{-11} ms^{-2}. The satellite is now in its manufacturing phase and its launch is planned for the year 2000 or early 2001. An elliptical orbit has been chosen so that the mapping of the atmosphere will be as detailed as possible and the direct solar radiation pressure can be used to calibrate the device. The prime contractor for the MIMOSA project is the Company Space Devices in Prague.

C. International Gamma Ray Astrophysics Laboratory

5. The Czech participation in the International Gamma Ray Astrophysics Laboratory (INTEGRAL), a cornerstone astrophysical satellite mission of ESA, includes the development of the on-board optical monitoring camera (OMC) experiment, participation in the INTEGRAL Science and Data Centre and the preparation of a ground-based segment with the related test and supporting experiments. The participation in the OMC experiment focuses on the ground-based OMC test camera device and on the OMC image simulator. The work is coordinated by the Astronomical Institute of the Czech Academy of Sciences and includes the design, development and testing of several software packages. The launch is planned for late 2001.

D. Hard X-ray spectrometer

6. The Hard X-ray Spectrometer (HXRS) is a joint venture of the Astronomical Institute of the Czech Academy of Sciences and the Space Environment Center of the National Oceanic and Atmospheric Administration of the United States. The satellite measurements should demonstrate the feasibility of predicting interplanetary energetic proton events by detecting a specific type of solar flare known to be associated with those events. HXRS was developed and constructed by the Czech company Space Devices. It is scheduled for launch together with the Multispectral Thermal Imager in October 1999. Its expected lifetime is three years, which should encompass the peak years of solar cycle 23. The data received from the experiment will be used simultaneously by Czech astronomers for research on solar flare physics.

III. Earth observation

7. Within the framework of the Phare programme, the digital database has been built up of land-cover units over the entire country on the scale 1:100,000. The Coordination of Information on the Environment (CORINE) methodology was applied, using a visual interpretation of Land Remote Sensing Satellite (Landsat) thematic mapper geocoded images followed by the digitalization of drawn results. In order to cover the whole territory of the Czech Republic, nine images have been used. The database is consistent with similar products elaborated in other European countries. The database is used in various applications such as environment analysis, soil degradation assessment and air pollution modelling.

8. Data from synthetic aperture radar (SAR) on European remote sensing satellites (ERS-1 and ERS-2) have been used for the production of space maps on the scale 1:200,000. Several image maps have been produced for geological and geomorphological analysis. GISAT, a company based in the Czech Republic, has used the data for mapping the geological situation for new oil pipeline construction, for the identification of potential nuclear dump sites and for regional geomorphological analysis. Radar interferometry has also been applied to obtain a grid model description with a spatial resolution of 20 m and an error in elevation of 10-20 m.

9. Several images of the floods in the Czech Republic were obtained using the Canadian satellite RADARSAT in July 1997. The SAR data were obtained thanks to close cooperation with the satellite programming centre. The semi-manual interpretation of the flooded areas carried out by the company GISAT has led to a map of the flooded areas. The map has been used in further studies and analysis of flood phenomena and in planning appropriate protective measures in the areas concerned.

IV. Materials sciences

10. The activities in the field of material sciences have focused mainly on three basic areas of research: (a) theoretical background of materials experiments; (b) development and manufacturing of crystal-growing space facilities; and (c) materials experiments in space. The Czech company BBT Materials Processing developed the first Czech version of fully automatic space crystallizers CSK-1A and B, followed by an improved CSK-1C version and consequently a CSK-4/TITUS furnace. All crystallizers functioned on board the manned Mir space station, including the EUROMIR 94 and EUROMIR 95 missions under the ESA programme, as well as the German MIR 97 and the French MIR 99 missions. The TITUS facility used in the experiments is a fully modular tubular crystallization furnace. At present, BBT Materials Processing is developing (in cooperation with the Microgravity User Support Center of the German Aerospace Center (DLR-MUSC) and with Humboldt University) a new generation of the Advanced TITUS facility for the international space station.

V. Life sciences

11. Research and studies are under way to elaborate a methodological tool for describing the behaviour of space crew members. Several experiments were carried out in the past by the Stress Research Centre of the Czech Air Force, together with Russian and German partners. Staff of the Centre participated in the ESA experiment HUBES in 1994, when a 135-day space flight was simulated in laboratory conditions. A similar experiment was organized in Moscow in 1995. Since 1996, the research has been aimed at the verification of an expert semi-automatic system for the early on-line detection of stress, in cooperation with

the German Institute for Stress Research. The feasibility of the continuous recording of mutual relations during the experiment and the early detection of tensions inside the group has been proved. A new method of dynamic sociometry has been developed based on the interdisciplinary approach combining biology, psychology and sociology.

VI. Industry

12. Today, all recent technologies are available in the Czech Republic without any serious limitations. In the past, when such technologies were not available, the engineers were trained in inventing and problem-solving. That proved to be a big advantage in absorbing technologies after the political changes in 1989 and it naturally led to the identification of optimal and efficient technical solutions. The engineers are involved in space projects that suit their qualifications and specific knowledge of technology. Project management follows western European standards—including ESA standards—and, thus, creates a framework for excellent results. The activities of several Czech space-oriented industrial companies are described below:

A. Space Devices

13. The company Space Devices was established in 1991 as a small private firm specialized in the development and manufacturing of scientific instruments for space research. The founders of the firm profited from their experience in the INTERCOSMOS programme between 1967 and 1990. The leading technicians became specialists contributing to INTERCOSMOS projects such as Vertilal, Prognoz, Vega, Mir, Phobos, Interball and Koronas. While the manufacturing is done by cooperating enterprises under supervision, specialists from Space Devices are responsible for the integration, testing and calibration of instruments.

B. Science Systems (CR)

14. Science Systems (CR) is a Czech company owned by Science Systems Space Ltd. of the United Kingdom of Great Britain and Northern Ireland. Science Systems (CR) provides consultancy and development of software systems for high-tech applications, such as satellite ground control systems and satellite data processing. Recent projects include subsystems for Envisat (the most complex satellite yet to be launched by ESA), testing for a distributed satellite ground segment system and engineering support in the development of the newest ESA satellite control system, which is being provided directly on site in the European Space Operations Centre. The company staff has also participated in the development of the Telemetry Tracking Command Unit for the Spanish satellite HISPASAT, a mission control centre core facility for the Meteosat Transition Programme, the satellite EUROSTAR and the European part of the Iridium project. The company also has working relationships with the National Commission on Space Activities (CONAE) of Argentina and the Instituto Nacional de Pesquisas Especiais (INPE) of Brazil.

C. Czech Space Research Centre (CSRC) Consortium

15. The Czech Space Research Centre (CSRC) Consortium consists of four companies that offer capabilities in electronic design, development and clean-room manufacturing. The lead company CSRC is responsible for task definition, project management and quality assurance. CSRC Manufacturing assembles electronics in its "D" class clean room. The room, which has been certified by ESA, a "100,000" class room with dimensions 6 x 6 x 2.5 m. The design and

development of electronics are the responsibilities of the KB Company. The development of software and computer systems is the responsibility of the ARTISYS Company.

16. The (CSRC) Consortium has developed harness test equipment for testing the perfection of spacecraft harness, electronics for the plastic scintillator anti-coincidence experiment on the INTEGRAL satellite, electronics for testing the charge couple device (CCD) camera designed for the European Photon Imaging Camera (EPIC) experiment on the X-ray Multi-Mirror (XMM) satellite. Other activities include several software modules for the controlling system of the ESA Plasma Wind Tunnel and a technological prototype of the inter-satellite communication board. The latter will make it possible to process signals in different protocols and transmission rates (e.g. between ESA and NASA satellites).